IN THE US PATENT AND TRADEMARK OFFICE

Inventors:
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US Application No.: **not assigned**

claiming priority from:
International Application No.: PCT/IL99/00028

International Filing Date: January 15, 1999

Priority Date: January 26, 1998

For: ENDOSCOPIC TUTORIAL SYSTEM

Attorney Docket: S02/11

Commissioner of Patents and Trademarks
Washington, D.C. 20231
USA

AMENDED CLAIMS ACCOMPANYING NATIONAL PHASE APPLICATION

Sir:

Enclosed please find a copy of the above-referenced claims, which were amended under PCT Article 19, and which are respectfully submitted with the filing of the above-referenced National Phase Application.

Respectfully submitted,

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Date: July 20, 2000

39. A system for performing a simulated medical procedure, comprising:

(a) a simulated organ;

(b) a simulated instrument for performing the simulated medical procedure on said simulated organ;

(c) a locator for determining a location of said simulated instrument within said simulated organ; and

(d) a visual display for displaying images according to said location of said simulated instrument within said simulated organ for providing visual feedback, such that said images simulate actual visual data received during an actual medical procedure as performed on an actual subject, said visual display including:

(i) a mathematical model for modeling said simulated organ according to a corresponding actual organ, said model being divided into a plurality of segments, said plurality of segments being arranged in a linear sequence;

(ii) a loader for selecting at least one of said plurality of segments from said linear sequence for display, said at least one of said plurality of segments being selected according to said location of said simulated instrument within said simulated organ;

(iii) a controller for selecting a simulated image from said segment according to said location of said simulated instrument, such that said simulated image is more rapidly displayed by being selected from said segment; and

(iv) a displayer for displaying said simulated image.

40. The system of claim 39, wherein said loader further comprises a rapidly accessed memory for storing said segment.

41. The system of claim 39, wherein said mathematical model features a plurality of polygons defined with respect to a spline, said spline determining a geometry of said mathematical model in three dimensions.

42. The system of claim 41, wherein said simulated instrument is an endoscope featuring an endoscope cable, said endoscope cable forming a loop from a movement of said endoscope in said simulated organ, said loop being modeled according to a mathematical model.

43. The system of claim 42, wherein said mathematical model for said loop features a plurality of polygons defined with respect to a spline.

44. The system of claims 42 or 43, wherein a size of said loop is determined according to a differential between an amount of said endoscope cable within said simulated organ and a length of said simulated organ from an entry point of said endoscope to a current position of said endoscope within said simulated organ.

45. The system of claim 39, wherein said visual displayer further comprises:

(v) a texture mapping database for storing texture mapping data, said texture mapping data including at least a correction for a visual artifact; and

(vi) a texture mapping engine for overlaying said simulated image with said texture mapping data substantially before said simulated image is displayed by said displayer.

46. The system of claim 39, wherein said segment is selected according to a location of said simulated instrument relative to a location of said segment in said linear sequence and within said mathematical model.

47. A method for modeling a loop during a performance of a simulated endoscopic procedure on a simulated organ, the simulated organ being modeled by a mathematical model according to a corresponding actual organ, the model being divided into a plurality of segments, the simulated endoscopic procedure being performed with a simulated endoscope having an endoscope cable, the method comprising the steps of:

(a) inserting the simulated endoscope into the simulated organ;

(b) turning the simulated endoscope within the simulated organ;

(c) modeling a loop of the endoscope cable forming as a result of turning the simulated endoscope within the simulated organ according to a second mathematical model; and

(d) providing at least one of force feedback and visual feedback determined according to second mathematical model of said loop and the mathematical model for the simulated organ.

48. The method of claim 47, wherein said second mathematical model and the mathematical model are each composed of a plurality of polygons defined with respect to a spline, each spline determining a geometry of said second mathematical model and the mathematical model in three dimensions.

49. The method of claim 48, wherein step (c) further comprises the step of determining a size of said loop according to a differential between an amount of the endoscope cable within the simulated organ and a length of the simulated organ from an entry point of the simulated endoscope to a current position of the simulated endoscope within the simulated organ.

50. A method for modeling a local deformation of a simulated organ by a simulated instrument during a performance of a simulated medical procedure on the simulated organ, the simulated organ being modeled by a mathematical model according to a corresponding actual organ, the model being divided into a plurality of segments, the method comprising the steps of:

(a) inserting the simulated instrument into the simulated organ;

(b) determining a location of the simulated instrument relative to a location of the simulated organ; and

(c) if contact is determined to have occurred according to said location of the simulated instrument relative to said location of the simulated organ, determining a deformation to the simulated organ according to the mathematical model.

51. The method of claim 50, wherein step (c) further comprises the step of determining if said deformation includes a deformation of the mathematical model.

52. The method of claim 50, wherein the mathematical model includes a plurality of polygons, the method further comprising the step of:

(d) adding a plurality of polygons to a portion of the mathematical model representing an area of said deformation; and

(e) adjusting a visual representation of said area of said deformation with said plurality of polygons.

53. The method of claim 52, further comprising the steps of:

(f) adding a plurality of polygons to a portion of the mathematical model representing an area of local irregularity in the simulated organ; and

(g) adjusting a visual representation of said area of local irregularity with said plurality of polygons.

54. A computer readable medium encoded with a method for performing a simulated medical procedure, the simulated medical procedure being performed with a simulated instrument on a simulated organ, the steps of the method being performed by a data processor, the method comprising the steps of:

(a) constructing a mathematical model for simulating the simulated organ, said mathematical model featuring a plurality of segments arranged in a linear sequence;

(b) determining a location of the simulated instrument in the simulated organ;

(c) selecting a segment of said mathematical model according to said location of the simulated instrument;

(d) selecting a simulated image from said segment according to said location of the simulated instrument; and

(e) displaying said simulated image.

55. A device substantially as described in Figures 1-9E and in the text of the specification.

56. A device for providing force feedback for simulating a medical procedure performed with a simulated instrument, the device comprising:

(a) at least one inflatable ring for being contacted by the simulated instrument and for providing the force feedback on the simulated instrument;

(b) at least one tube connected to said at least one inflatable ring for alternately inflating and deflating said at least one inflatable ring; and

(c) a pump connected to said at least one tube for alternately pumping air into, and suctioning air from, said at least one inflatable ring for controlling an amount of the force feedback on the simulated instrument.

57. A method for rendering a plurality of images according to a three-dimensional structure, the steps of the method being performed by a data processor, the method comprising the steps of:

(a) providing a mathematical model of the three-dimensional structure, said mathematical model including a spline;

(b) dividing said spline into a plurality of segments, each segment including at least one image;

(c) selecting a segment for rendering an image; and

(d) rendering said image.